



## ISSUE: IMPROVING THE SAFETY OF THE ROAD ENVIRONMENT

### What is road environment safety?

Road environment safety is the term used to describe the safety aspects relating specifically to road design, traffic management, the roadway and its adjoining surroundings and environmental conditions as distinct from other road safety issues such as road user behavior or vehicle design and performance.

The state and local transportation agencies can reduce crashes and casualties by providing a safer road environment through improvements in the design, construction and development of the road network, and in the management of the traffic it carries.

The road environment and the vehicles using it should be designed, built and maintained to inform the road user and to minimize the outcomes of human error. A well-designed road should allow road users to accurately perceive the "demands" of the road environment and perform the required road user task. If there is a failure in the road user's ability to accurately perceive this demand, then the roadway should be forgiving by either allowing the road user to recover and continue (thus changing the outcome of the event) or by minimizing the severity of the crash. Roadways are designed, built and maintained to achieve these objectives.

Over time, breakdowns in the safety and efficiency of portions of the road environment can occur as a result of the site's changing characteristics. Characteristics that may contribute to a crash include increased traffic volumes and congestion, faster or irregular speed patterns, changes in vehicle types, sizes and mixes, and different patterns of use (rural to urban/residential to commercial).

The Iowa DOT is continually assessing its crash data to identify crash-prone locations and trends or patterns in crash types. In particular,

the department looks for areas where fatal and major injury crashes are most likely to be repeated unless some countermeasure is implemented.

Safety countermeasures are focused on reducing the exposure of risks, eliminating risk factors and reducing the consequences of accidents.

There are many countermeasures including legislation and regulatory reforms that can be deployed to make roadways safer and improve vehicle flow. As the highway industry gains knowledge and experience, new technologies emerge and new products are developed, additional solutions are made available.

### What countermeasures and new design and product solutions have been or are currently being used by the DOT to improve the roadway environment?

It is estimated that roadway design is an important factor in one-third of traffic fatalities. The table below describes just a few of the strategies employed by the state over the last several years to increase the efficiency of Iowa's roadway system, and significantly enhance safety and reduce injuries and fatalities.

The Federal Highway Administration has found that every \$100 million spent on needed highway safety improvements will result in 145 fewer traffic fatalities over a 10-year period.

The job of designing the roadway and how it operates is twofold: first, to prevent crashes by keeping the driver on the roadway and in their lane and to limit conflicts with roadway hardware or other vehicles; and, second, when crashes do occur provide conditions that reduce the risk of multiple vehicle collisions and severe injuries and fatalities.

Safety Issue	Countermeasures
<p><b>Intersection crashes</b></p> <p>Vehicle conflicts at intersections produce an overabundance of severe crashes with fatalities and serious injuries. Estimates by National Highway Traffic Safety Administration and other organizations indicate that more than 40 percent of all fatalities occur in vehicle collisions at or near intersections. This figure includes crashes resulting from any crossing conflicts, including ramp merging areas, driveways, and divided highway median crossovers. Intersection conflicts and crashes pose dangers to both vehicle occupants and pedestrians. In crashes at intersections, vehicle occupants are vulnerable to severe injury and death because the majority of the collisions involve side impacts into one of the vehicles. Side impacts have higher rates of death and serious injury because there is comparatively little protective structure to safeguard occupants in the struck vehicle.</p>	<ul style="list-style-type: none"> <li>• <b>Left turn lanes</b> –Having a signalized intersection with an arrow and a left turn lane (rather than leaving it to the judgment of the driver to determine when there is a sufficient break in traffic) will reduce the number of dangerous “right angle” collisions. “Offset” left turn lanes also improve visibility because the car going in the opposite direction doesn’t block you.</li> <li>• <b>Lighting</b> - Better lighting overall—with age, the lens of the eye becomes less clear and the pupil actually shrinks so less light enters the eye. Eyesight begins to worsen at age 40 and by 60, a driver needs 3 times more light to see as at 16. Since more light is required to see the same objects as we age, better lighting for both highways and city streets are needed.</li> <li>• <b>Signalization</b> - Upgraded signal phasing and timing to existing systems, as well as the addition of signals at unsignalized intersections; stop signs, roundabouts, and traffic signals can better control traffic flow and reduce intersection conflict points</li> <li>• <b>Local assistance</b> - Assisting local governments identify candidate safety projects and feasible solutions and providing funding assistance to make safety improvements at problem intersections</li> </ul>
<p><b>Safely accommodating pedestrians, bicyclists and road workers</b></p>	<p>A variety of techniques can be used to separate pedestrians and cyclists from motor vehicle traffic</p> <ul style="list-style-type: none"> <li>• Retroreflective pavement markings at crosswalks to increase visibility</li> <li>• Countdown signals so pedestrian knows the amount of time needed to safely cross</li> <li>• Longer walk times for slower paced pedestrians (3 ft/second)</li> <li>• Easier to reach and larger buttons</li> <li>• Pedestrian signal plaques (to help pedestrians properly understand signals)</li> <li>• Pedestrian refuge islands</li> <li>• Constructing pedestrian-only bridges over major highways</li> <li>• Adding a pedestrian lane, separated by a concrete barrier and fencing, on new bridges</li> <li>• Brighter school crossing signs</li> <li>• Recreational trails and bike paths parallel to the roadway</li> <li>• Paved bike-only lanes on roadways</li> <li>• Local safety teams of state, city and county engineers, law enforcement, maintenance, emergency response, and planners address local traffic and safety problem areas and implement local solutions (i.e. designing and managing vehicle and pedestrian traffic near schools, shopping areas, or senior housing locations)</li> <li>• Brighter work zone signage and worker apparel</li> </ul>

**Run-off-the road/roadway departure crashes**

Crashes resulting from simply leaving the roadway, regardless of the underlying cause, represent a substantial portion of the total crash problem. They occur on both straight and curved sections and often involve either rollover of the vehicle or collisions with fixed objects such as trees or utility poles.

Countermeasures emphasize "keeping vehicles on the roadway," and "minimizing the consequences of leaving the roadway."

- **Stabilizing shoulders** – Wider and partially paved shoulders provide a forgiving environment because they help drivers control their vehicles and return to the traveled portion of the roadway
- **Rumble strips** – Regular undulations in the paved surface along the shoulder provide an auditory and tactile signal to alert drivers encroaching on the road shoulder or approaching some other potentially hazardous situation; centerline rumble strips will be installed on selected roadways where a high number of cross centerline head-on crashes occur
- **Signing, pavement marketing and delineation** – Traffic signs, pavement markings and reflective devices improve driver perception of important roadway features and alert them to changes in roadway geometry or other conditions
- **Clear zones** – Areas of open space adjacent to the road, clear of trees and other obstacles, giving motorists room to safely regain control of their vehicles if they run off the road
- **Gradual side slopes** – Gentle slopes along the roadway create less risk of vehicles overturning if they leave the road and help drivers regain control
- **Forgiving devices** – Roadway features such as signs and utility poles with breakaway impact, barrier walls or guardrails which redirect vehicles away from hazards, culverts that are extended, crash cushions near bridge piers to absorb energy and lessen the severity of crashes
- **Increased surface friction** – Greater road surface friction provides drivers with increased traction for maneuvering and stopping
- **Preventative maintenance** – Maintenance can eliminate drop-offs between the road pavement and shoulder or adjacent lane that can cause drivers to lose control when attempting to return the vehicle to the road surface. Regular maintenance to repair potholes can also eliminate erratic maneuvers by motorists.
- **Safety barriers** – Installation of appropriate safety barriers where a hazard-free run-off area is not available reduces the severity of the crash by allowing errant vehicles to be contained and possibly redirected by the barrier; this includes installation of wire barriers on high volume divided highways to prevent traffic from crossing the median

<p><b>Deficiencies in geometric design of the roadway</b></p> <p>The configuration, or geometry, of a highway has two main parts: its alignment, that is, how the road is laid out linearly before the driver; and the width of its lanes, shoulders, and immediate roadside environment. Crashes related to deficiencies in the roadway's design, such as sight distance, curve radii, paved width and shoulder, and roadway slope place drivers at a considerably increased risk of losing control of their vehicles and having either a single-vehicle crash, especially off the road, or a collision with another vehicle.</p>	<ul style="list-style-type: none"> <li>• <b>Straighten or soften curves/adjust horizontal alignments</b> - Horizontal alignment should provide for safe and continuous operation at a uniform design speed for substantial lengths of highway. The major considerations in horizontal alignment design are safety, profile, type of facility, design speed, geotechnical features, topography, right-of-way cost and construction cost.</li> <li>• <b>Improve sight distance</b> - Sight distance is the continuous length of highway ahead visible to the driver. Three types of sight distance are considered here: passing, stopping and decision.</li> <li>• <b>Flatten steep grades</b> - The grade line is a reference line by which the elevation of the pavement and other features of the highway are established. It is controlled mainly by topography, type of highway, horizontal alignment, performance of heavy vehicles, right-of-way costs, safety, sight distance, construction costs, cultural development, drainage, and pleasing appearance. All portions of the grade line must meet sight distance requirements for the design speed classification of the road.</li> <li>• <b>Access control</b> - Preventing uninhibited access into the facility from cross streets and driveways</li> <li>• <b>Median separation</b> - Separating traffic with a median rather than simply a centerline, thereby dramatically reducing the chances of head-on collisions</li> <li>• <b>Lane widening</b> - Lanes are wide so all types of vehicles using the facility can have reasonable lateral movement without collisions with adjacent vehicles</li> <li>• <b>Clear zones</b> - Roadsides are cleared not only so drivers can see far around curves, but also to allow vehicle departures from the travel lanes into the adjacent environment without suffering serious impacts with dangerous features such as telephone poles, trees, boulders, drainage structures, or encountering steep ditches that can induce vehicle rollovers</li> <li>• <b>Pavement markings</b> - Lanes, shoulders, and intersections are clearly marked</li> <li>• <b>Guidance and warning signs</b> - Signs are large, bright, and legible, and signals are conspicuously placed, so that drivers have ample time to make decisions before encountering changed operating circumstances</li> </ul>
<p><b>Conflict points among vehicular movements</b></p>	<ul style="list-style-type: none"> <li>• <b>Separating at-grade intersections</b></li> <li>• <b>Urban access control:</b> Restricting curb cuts and direct-access driveways on roadways in commercial areas</li> <li>• <b>Expressway access control:</b> Limiting access by spacing intersections farther apart on four-lane highways and interstates</li> <li>• <b>Frontage roads:</b> Building frontage roads to collect local business traffic</li> <li>• <b>Longer merge and acceleration lanes on to expressway and freeway facilities</b></li> </ul>

<p><b>Narrow roadway crashes</b></p>	<ul style="list-style-type: none"> <li>• <b>Widening lanes</b> – Wider lanes provide a larger road surface on which to maneuver in an emergency without leaving the road surface</li> <li>• <b>Adding or widening shoulders</b> – Shoulders provide drivers with additional room to maneuver on narrow roads</li> <li>• <b>Rumble strips</b> – Providing partially paved shoulders and shoulder rumble strips</li> <li>• <b>Channelization</b> – Separate lanes for left- or right-turning traffic and for slower climbing vehicles avoid impediments to traffic flow which can lead to rear end crashes</li> <li>• <b>Removal of curb and gutter systems</b> – Many of Iowa's roadways were originally constructed with curb and gutter systems, curbs have been removed and replaced with improved drainage systems</li> <li>• <b>Four-laning</b> - A number of high volume two-lane highways in the state, which had a history of a high number of fatal and major injury crashes, have been upgraded to four-lane, divided highways; the crash rate can be reduced by 30 to 40 percent by converting a two-lane road to a four-lane road on high volume corridors</li> <li>• <b>Three-lane roads</b> – Converting high crash four-lane undivided urban streets to three-lane divided roadways</li> <li>• <b>Bypasses</b> – Bypasses eliminate vehicle conflict points on higher speed roadways such as at-grade intersections</li> <li>• <b>Brighter road markings</b> - Brighter edge markings and other pavement markings allow drivers to see their lanes and intersections/crosswalks more easily, preventing cross-overs, run-off-the-road, and pedestrian and bicycle crashes</li> </ul>
<p><b>Narrow bridge crashes</b></p>	<ul style="list-style-type: none"> <li>• <b>Widening bridges</b> – Wider lanes and shoulders</li> <li>• <b>Bridge treatments</b> – The addition of safety features such as crash cushions or guardrails as transitions to the bridge ends reduce crash severity</li> <li>• <b>Signing, pavement marking and delineation</b> – Signs and pavement markings alert drivers to approaching narrow bridges and allow them to position their vehicles most safely when crossing</li> </ul>

<p><b>Conspicuity and the legibility of traffic control devices</b></p> <p>Traffic control devices, such as signs, pavement markings and signals, are essential in promoting highway safety. They assist drivers in knowing exactly where they are on a roadway, especially at night and under adverse weather conditions, and they alert drivers about what to expect ahead.</p>	<ul style="list-style-type: none"> <li>• <b>Improving pavement marking retroreflectivity and durability</b> - At night, most traffic control devices, including signs, are conspicuous because they rely on retroreflectivity, the ability to reflect light cast on to the surface of the device. The DOT is using brighter and more durable pavement markings.</li> <li>• <b>Increasing sign retroreflectivity and brightness</b> – Over the last few years all school crossing signs on state highways have been replaced with brighter fluorescent yellow signs; the color and brightness of work zone signs has changed; all new and replaced yellow warning signs will use a brighter signing material</li> <li>• <b>Enhancing the legibility and location of signs</b> - Legible traffic signs are easily read and understood by all drivers, again, in enough time so that crucial driving decisions can be made early. Signs rely on both word messages and symbol messages, and sometimes a combination of the two. Proper location of signs can often decrease the risk of crashes. Legibility of signs and placement far enough away from a driver's maneuvering decision point can reduces sudden and erratic driving maneuvers.</li> </ul>
<p><b>Speed management</b></p> <p>The risk of being injured or killed in an accident increases considerably with increased speed. With the repeal of the national speed limit law, there is renewed interest on how best to set and enforce speed limits. Speed management is a complex issue involving engineering and behavioral factors.</p>	<ul style="list-style-type: none"> <li>• Adoption of travel speeds appropriate for the class of road, roadway design, and travel conditions</li> <li>• Conducting site specific speed studies in coordination with local governments</li> </ul>
<p><b>Traffic safety analysis and support</b></p>	<ul style="list-style-type: none"> <li>• Maintain one of the nation's most complete and timely statewide vehicle crash databases. This data is used to identify and analyze roadway segments to develop potential safety improvements.</li> <li>• Provide and receive instruction on low-cost safety improvements</li> <li>• Utilize the state funded Traffic Safety Improvement Fund to pay for safety improvements, improve traffic control devices and conduct safety research</li> <li>• Iowa's Safety Management System has developed a toolbox of highway safety strategies to implement ways to improve highway safety. This is a collaborative effort between many private and public agencies.</li> <li>• Implemented a safety audit program on 3R (repair, resurface, rehabilitate) projects to enhance the safety of the roadway during resurfacing projects</li> </ul>